2011 International Conference on User Science and Engineering (i-USEr)

Interactive Multimedia-Based Learning for Network Cable Installation Course

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Abstract— **This article presents the design and evaluation of an interactive multimedia courseware for Network Cable Installation Course at the Community College. The limitations that exist in the conventional learning approach are described. This led to the development of an interactive multimedia courseware to be used in the teaching and learning process. The developed courseware was then evaluated on its usability in terms of perceived of usefulness, perceived of ease of use, learnability and future use of the courseware. It is found that overall the courseware receives high ratings from respondents and the highest rating among all suggests that respondents agreed that overall they found that the courseware is useful to complete their learning task.**

Keywords - interactive multimedia; multimedia-based learning; network cable installation course; courseware

I. INTRODUCTION

Network Cable Installation is one of the courses offered in the Certificate of Computer System and Support Program at the Community College, Ministry of Higher Education. This program is offered to all candidates especially "Sijil Pelajaran Malaysia (SPM)" school leavers. The Network Cable Installation course consists of various topics which include cable types, connectors, equipment, cable patching, and network wiring. Two approaches are normally used by lecturers during teaching and learning: theoretical and practical. These two approaches are adopted based on the syllabus requirements at the Community College where 25% is theoretical while 75% is practical. This course is offered during the final semester or fourth semester in order to complete the requirements of the program before graduation.

Teaching and learning process is the main focus of this study whether it is effective amongst students in the Community College especially the Bandar Darul Aman Community College, Jitra, Kedah. Usually, there are two lecturers conducting one class, with the average students from 25 to 30. The College also has 2 to 3 classes for each semester, first until fourth semesters. Conventionally, lecturer completed the syllabus on theoretical through lectures, question and answer sessions, giving notes, discussion, slides presentation and online browsing.

The Network Cable Installation course is taught at the Network Lab or Computer Lab equipped with network equipments. Students would have to work in groups during the practical session. Unfortunately, the equipments in the lab are limited, only a set of equipment is available for each group. There are 2 to 3 members in a group sharing a set of equipment during the learning process which results that some students have no opportunities in using it during the practical session. Sometimes not all equipments are fully functional which escalates the problem that already existing.

Normally while teaching this course at the community college, the lecturer would demonstrate the cable installation using the equipment available. Students initially observe their lecturer and then proceed to conduct the cable installation in a group. It depends on the group creativity in making sure that all members have the opportunity to perform the cable installation process. For the theoretical session, most of the lecturers use conventional teaching techniques such as "chalk and talk", printed notes and slides presentation to teach their students.

Students are assessed theoretically and practically through continuous assessments and final examination. For these assessments, students will have to make preparation or revision to ensure that they will score in that course. Normally, their main source of references are books and lecture notes. However, most books and notes have mainly text with limited diagrams related to the course. The diagrams are static, non-interactive and could not present step-by-step process in network cable installation.

Online materials related to network cable installation are available for students to access such as from YouTube. But sometimes, not all students own a notebook or a computer with Internet access. Moreover, it is quite slow to loading and streaming YouTube materials through online access. Students, at their own expense, took an initiative to register and pay monthly installment for an Internet Service Provider at home. Although they can use the College computer facilities, sometimes several web sites especially related to streaming, are blocked.

Therefore, in order to overcome the limitations that exist with the existing teaching/learning process and student conditions, a supplementary teaching/learning approach is proposed in this study.

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II. BACKGROUND

A. Interactive

Interactive refers to a responsive nature of a system. Being interactive means that when a user does something, it changes what happens next [1]. Interactive is a form of communication that transfers information between a user and a central communication system.

B. Multimedia

Multimedia is any combination of media elements, such as text, graphic, animation, video, and sound involving the use of computers [2]. Therefore, an individual needs can be achieved by this combination [3]. Multimedia may also refer to the use of different media to express information consist of text together with audio, graphics and animation, often packaged on CD-ROM with links to the Internet [4].

C. Courseware

Courseware is learner-centered, which encourage students to self-paced learning. The good courseware provides an entire learning environment, including target content, personalization, feedback, remediation, and various learning and evaluation methods [5], [6]. The use of courseware integrates assorted skills such as listening, reading, and comprehension, together with real learning experiments, learners' control over their learning and a focus on the content of subject [6], [7].

Courseware is defined as an educational material intended as kits for teachers or trainers or as tutorials for students, usually packaged for use with a computer [8]. It can cover any knowledge area, but information technology subjects are most common. Courseware is frequently used for delivering education about the personal computer and its most popular business applications, such as word processing and spreadsheet programs. Besides that, courseware is also widely used in information technology industry certification programs, such as the Microsoft Certified Systems Engineer (MCSE) and the Computing Technology Industry Association's A+ examination. Courseware can include:

- Material for instructor-led classes
- Material for self-directed computer-based training (CBT)
- Web sites that offer interactive tutorials
- Material that is coordinated with distance learning, such as live classes conducted over the Internet
- Videos for use individually or as part of classes

D. Teaching and Learning Issues

Adapting instructions to individual behavior is not always possible due to large classroom size and limited teaching time, but with the development of ICT, instructional software can be developed at a cheaper cost and used to help in tutoring students with learning problems. Since individual differs in cognitive ability, earlier knowledge and learning styles, adapting instruction to cater these differences can make learning easier.

Interactive multimedia courseware can be easily designed to provide individualized instruction for students who fail to learn through a conventional way. They have been used effectively to teach various subjects [9]. In education, software packages become more important to be used in the classroom because it can motivate the learning process. However, the resources available on the market, with the designation of educational software, often have a doubtful quality. Thus, a constitution of a multi-disciplinary team with different competencies (Science Education, Educational Technology and Design) is a must in order to assess the development of educational software for teaching and learning environments and to properly evaluate the software quality [10].

Teaching courseware is an important resource of teaching and should be equally emphasized as traditional teaching technique [11]. It is the supplementary teaching software which is based on one or several points of the implementation of relatively complete teaching and it is the natural combination of teaching strategies and teaching contents. To improve the quality of classroom instruction, it is very important to design and develop high quality courseware. But due to the own characteristics of multimedia courseware, its manufacture process particularity is determined. Some teachers' knowledge in this aspect are limited, so in the design of multimedia courseware they always feel overwhelmed when facing the multifarious design software, pictures, animations and sound material. Multimedia courseware making is a teaching production process, making a perfect function of courseware must involve more software and computer technology, pedagogy, psychology and professional knowledge of what the curriculum of understanding and mastering situation. Therefore, the basic theory of education technology research is very important. Curriculum development theory research is an important part of the basic theory of education technology, and courseware development mode is the important content of the theory of curriculum development.

Beyond curriculum and facility innovation, another change in engineering education is the inclusion and exploitation of electronic means for teaching of course material. Engineering courseware with computer-based material can be used to assist engineering students in their learning process. Typically, this courseware takes advantage of multiple media formats, such as graphics, images, sound, video, and animation to illustrate engineering concepts, products, or practices. This multimedia software provides a new level of interactive learning, where the philosophy is that multimedia courseware will cross over all learning styles and even make learning fun [12].

E. Usability Evaluation

The usability evaluation has been developed on the courseware by means of five constructs: effectiveness, learnability, ease of use, flexibility and user attitude [13]. Significantly higher results were obtained for the matched group compared with the mismatched group while [14] emphasized four constructs of usability evaluation. The constructs discussed were perceived usefulness, perceived ease of use, learnability and outcome or future work of the courseware. The final results achieved in the software evaluation made by teachers which include the software

technical (software and user's manual) and educational (guidelines for the Didactic Exploration – Teacher and guidelines of Records - Student/User) aspects were reported [10]. With the data gathered and results achieved, it is possible to assess the usefulness of the end user evaluation of educational resources and the quality of the courseware. This evaluation enables to improve aspects related with the usability (navigation and interaction) and enables us to ensure the capability of the courseware to the target educational level.

F. Development of Courseware

Researcher interested in the developing multimedia courseware by [15] used the Multimedia Authoring Process (MAP) which is a 3-stage procedure. The three stages are Pre-authoring, Authoring process and Post-authoring.

III. Research Methods

A. Suggestion

Suggestion phase describes about new idea that will be used to propose new functionality of the artifact to be developed. In this study, suggestion is to use curriculum as a guideline and an idea in this step. The starting point is ironically the visualization of the ending point. It involves identifying a relevant theme for the multimedia software title.

B. Development

Researcher made decision to choose the methodology of Neo & Neo [16] and the methodology will be adapted to match with NCI Courseware. As shown in Fig. 1, the multimedia for learning course using a tool consists of the following steps which are assembling the media elements needed to represent the educational content, digitizing the analogue media, editing the media elements, multimedia authoring, and packaging for delivery on a CD-ROM.

1) Digitizing the analogue media

The media elements such as the images, videos, audios, animations, photo of background and text of contents are collected and stored it in the disc drive or CD.

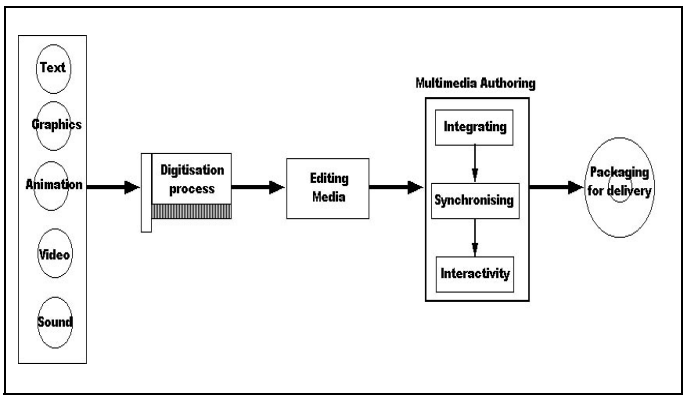


Figure 1. Diagram of the Multimedia Design Process (MDP).

2) Editing the media elements

All media elements that have been digitalized were stored in the PC or disc drive. Editing the media in digital was easy compared to documentation.

3) Multimedia authoring

Authoring the courseware was the step to accomplish development of courseware.

4) Packaging for delivery on a CD-ROM

The courseware is converted into CD-ROM and it can be copied to more than one CD-ROM for users' implementation in the computer lab or home.

This five steps of process looked not very complicated to follow and quite suitable with NCI Courseware development. NCI Courseware was not an e-learning concept but it was a standalone courseware whereby using the CD-ROM as a packaging for delivery. Users implement the courseware using PC or notebook by their own or computer lab.

C. Evaluation of Application

Evaluation was conducted among 46 students and 2 lecturers to measure their perception in term of acceptance and learnability. The performance of the application is measured based on learnability, usefulness, ease of use, functionality, effectiveness, satisfaction and outcome/future work.

IV. Courseware Development Method

The courseware development method of Multimedia Design Process (MDP) [15] was adapted. Adaptation of the method is made to match with NCI Courseware. The multimedia used for this learning course are Lecture MAKER 2.0 as an authoring tool with others editing tool to support the development of courseware such as YouCam3 with the notebook webcam (camera), Paint, audio recorder with microphone device and Windows Media Player.

The development method consists of:

- Creating the media elements.
- Converting the media to digital format.
- Editing the media elements.
- Multimedia authoring.
- Packaging for delivery on a CD-ROM

Following subsections describe the steps of the development method.

A. Creating the Media Elements

Creating the media elements is the first step of process in a courseware development. The content was based on the syllabus of the course to ensure validation. References were from notes, books and Internet.

Storyboard of the courseware was designed. Graphics, audios, videos, and images were collected and stored as raw materials. It is decided to apply hierarchy navigational scheme

as it is more straightforward and provides a relatively clean structure.

A storyboard is a design of screens before the courseware is developed. It shows the linking of screens exist and information of each elements for each screen. Fig. 2 illustrates a sample of storyboard that consists of project name, designer/author name, page title, page number, the interface screen design, and the description of multimedia elements.

B. Digitizing the Analogue Media

The media elements such as the images, videos, audios, animations, photo of background and text of contents were collected and stored in the disc drive or CD. Digital contents were made based on lecture notes and lectures were recorded to series of digital video.

C. Editing the Media Elements

All media elements that have been digitalized were stored in the PC or disc drive. Editing the media in digital was easy compared to documentation. Researcher made editing the elements of media depend on the format file whether it was audio, video, text, image and so on with the suitable existing tool.

The media of image used the Paint application provided by MS Windows to make editing for icon or button in the courseware. Usually, the suitable format file for icon is .png (portable network graphic) because the ability of transparent of courseware background. However, researcher also used .jpg or .jpeg (joint photographic expert group) because of the file size.

Captured video as recording video used the camera of notebook (webcam) and made edited by software called Cyberlink YouCam Version 3. The voice recording were conducted using the microphone and later on were saved in a folder. This recording was set up using Windows Media Audio, provided by the MS Windows. The message box needs the voice or audio as a reaction of our activities especially when the students answered the quizzes.

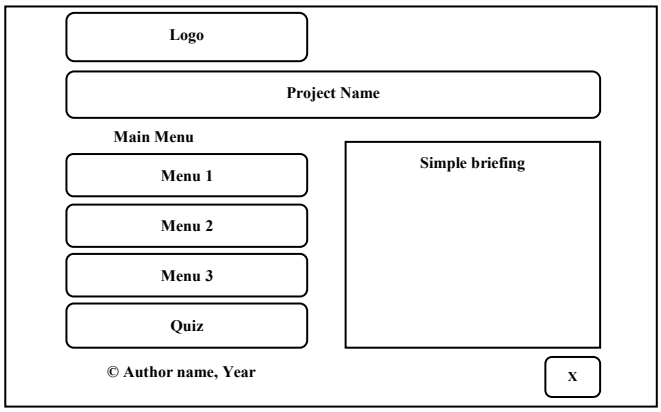


Figure 2. Storyboard design.

D. Multimedia Authoring

Authoring the courseware was the step to accomplish development of courseware. Previously, the information gathered included the main content to fill, the software of authoring, editing tools, created the structure of courseware and general flowchart, storyboard as a draft of multimedia authoring, element of digitalized media and this part will elaborate the authoring the interface of courseware.

Authoring software, Lecture MAKER version 2 was used based on the deployment requirement and due to interface familiarity as it is relatively similar with MS PowerPoint concept. It allows saving the courseware in the Flash format and the output of the courseware can be SCORM compliant. Besides, the courseware can be saved as executing file (.exe). This executing file allows the courseware to standalone and students may use it on self-learning method.

Fig. 3 depicts several screen shots of the NCI courseware. The courseware starts from the main page where users need to click Enter to begin learning. Main menu screen then lists out four modules and users may select any of these modules. Upon selection, the teaching materials were delivered by means of lecture, video and images.

At the end of the modules, users may opt for a quiz to recall their understanding of the subject. Fig. 4 depicts the quiz interface that applies radio button type of answers.

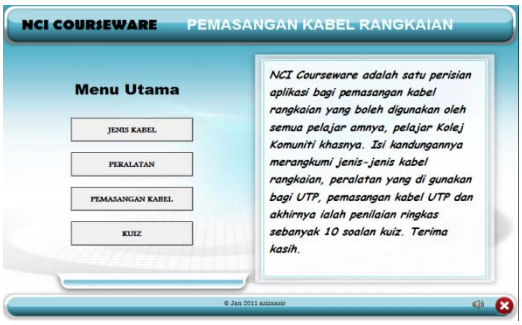
E. Packaging for Delivery on a CD-ROM

The courseware is saved as executable file (.exe) package. Before converting the courseware to the CD-ROM, it is better if the courseware is tested. Researcher tests the courseware repeatedly to ensure the courseware made minimum error or failure. Few lecturers were approached to look up the courseware and suggest further improvement. Finally, the courseware is converted into CD-ROM and it can be copied to more than one CD-ROM for users' implementation in the computer lab or home.

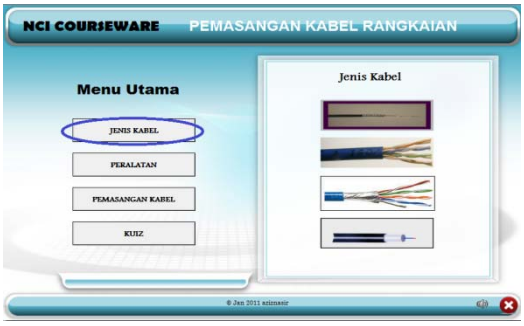
V. RESULTS AND DISCUSSIONS

There were 48 respondents participated in this evaluation. Majority were final semester students taking Certificate of Computer System and Support Programme. Data was collected from the respondents after they answered the questionnaire. They have been briefed on the objective of the study beforehand. Data were analyzed using Statistical Package for Social Sciences (SPSS) version 17. Descriptive statistic on the frequency was used on analyzing demographics as shown in Table 1.

a) Start screen.



b) Main menu screen.



c) Menu 1 - Cable type.

d) Content 1 – Explanation.

Figure 3. The NCI courseware modules.

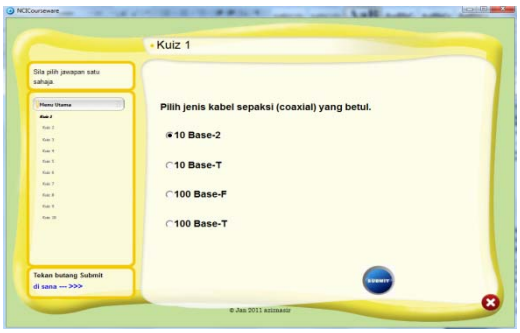


Figure 4. The NCI courseware quiz interface.

As shown in Table I, male (21, 43.8%) and female (27, 56.3%) respondents were balanced. Majority respondents were Malay (38, 79.2%) and students (46, 95.8%). Most participants have three (3) to six (6) years of computer experience.

A. Descriptive Analysis

Table II shows descriptive statistics for the entire items. It shows that overall NCI Courseware has a good usability. The measurement items used five Likert scales where 1 is a Strongly Agree to 5 is a Strongly Disagree.

All items were found to receive high ratings from respondents. It is found that Item 6 Overall I find my NCI Courseware useful (Mean=1.58, SD=.739) has the lowest mean value among others. Since scale 1 as Strongly Agree is used, this suggests respondents agreed that the courseware is useful.

B. General Observation

Observation was made on respondents while using the courseware during a two-hour lecture session. The reaction of respondents was observed. It is found that students paid more attention to the activities performed. It seems that respondents were found to enjoy using the courseware as it is accompanied by simple musical tunes and hence to feel motivated. In addition, they were not only seeing the text and figure as they were also engaged in video lectures during the process.

TABLE I. DEMOGRAPHIC PROFILE OF RESPONDENTS

Profile	Classifications	Frequency (%)
Gender	Male	21 (43.8)
	Female	27 (56.3)
Race	Malay	38 (79.2)
	Chinese	5 (10.4)
	Indian	3 (6.3)
	Others	2 (4.2)
Job	Student	46 (95.8)
	Lecturer	2 (4.2)
Computer experience	< 3 years	9 (18.8)
	3-6 years	20 (41.7)
	> 6 years	19 (39.6)

TABLE II. DESCRIPTIVE STATISTICS FOR INDIVIDUAL ITEMS

Item	Measurement	Mean (Standard Deviation)
	Usefulness	
1	NCI Courseware enables me to accomplish tasks more quickly.	1.83 (0.595)
2	Using NCI Courseware increases my productivity.	1.83 (0.559)
3	Using NCI Courseware improves my job performance.	1.81 (0.491)
4	Using NCI Courseware enhances my effectiveness on the job.	1.88 (0.703)
5	Using NCI Courseware makes it easier to do my job.	1.83 (0.834)
6	Overall, I find NCI Courseware useful in my job.	1.58 (0.739)
	Ease of Use	
7	Learning to operate NCI Courseware is easy for me.	1.79 (0.713)
8	It is easy for me to remember how to perform task using NCI Courseware.	1.75 (0.729)
9	My interaction with NCI Courseware is clear and understandable.	1.75 (0.700)
10	I find NCI Courseware burdensome to use.	3.10 (1.242)
11	I find it takes a lot of effort to become skilful at using NCI Courseware.	2.35 (1.229)
12	Overall, I find NCI Courseware easy to use.	1.83 (0.724)
	Learn Ability	
13	It is easy to learn NCI Courseware.	1.83 (0.883)
14	The information provided by NCI Courseware is easy to understand.	1.69 (0.689)
15	NCI Courseware provides clarity of wording.	1.71 (0.582)
16	The clearness and correctness of the content	1.73 (0.610)
17	The ordering of information is logical.	1.94 (0.727)
18	The information provided, helped me in job process.	1.67 (0.519)
	Future Use	
19	I was able to complete my job quickly using NCI Courseware.	1.92 (0.919)
20	I could effectively complete my job using NCI Courseware.	2.02 (0.699)
21	I was able to efficiently complete my job using NCI Courseware.	1.96 (0.798)
22	From my current experience with using NCI Courseware, I would use it regularly.	1.85 (0.714)

VI. CONCLUSION AND FUTURE WORK

This article has described the design and evaluation of an interactive multimedia courseware for Network Cable Installation Course at the Community College. The development methods and the interface design were described. The developed courseware was evaluated on its usability in terms of perceived of usefulness, perceived of ease of use, learn ability, and future use of the courseware. It is found that overall the courseware receives high ratings from respondents and the highest rating among all suggests that respondents agreed that overall they found that the courseware is useful to complete their learning task.

Future work is to expand the scope of the courseware to cover the whole course syllabus. Proper user requirements should be done in the early stage of the development to ensure the sustainability of such courseware. These would anticipate time, money, and effort from participating stakeholders. Lastly, to ensure that the courseware is truly effective, future evaluation shall assign a control group in order to compare the learning outcome of students using the courseware versus those using the traditional teaching method.

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